The Great Plains Laboratory, LLC

Requisition #:	1179575			*Practitioner:*	RN LABS
Patient Name:	Daniel Jarrett			*Date of Collection:*	03/26/2023
Date of Birth:	06/19/1987	*Patient Age:*	35	*Time of Collection:*	08:00 AM
Patient Sex:	M			*Print Date:*	04/13/2023
Specimen Id.:	1179575-2				

Organic Acids Test - Nutritional and Metabolic Profile

Metabolic Markers in Urine	Reference Range (mmol/mol creatinine)	Patient Value	Reference Population - Males Age 13 and Over
Intestinal Microbial Overgrowth			
Yeast and Fungal Markers			
1 Citramalic	0.11 - 2.0	1.1	1.1
2 5-Hydroxymethyl-2-furoic *(Aspergillus)*	≤ 18	2.3	2.3
3 3-Oxoglutaric	≤ 0.11	0.07	0.07
4 Furan-2,5-dicarboxylic *(Aspergillus)*	≤ 13	3.7	3.7
5 Furancarbonylglycine *(Aspergillus)*	≤ 2.3	0.15	0.15
6 Tartaric *(Aspergillus)*	≤ 5.3	H 27	27
7 Arabinose	≤ 20	H 33	33
8 Carboxycitric	≤ 20	0.04	0.04
9 Tricarballylic *(Fusarium)*	≤ 0.58	0.07	0.07
Bacterial Markers			
10 Hippuric	≤ 241	227	227
11 2-Hydroxyphenylacetic	0.03 - 0.47	H 8.7	8.7
12 4-Hydroxybenzoic	≤ 0.73	0.30	0.30
13 4-Hydroxyhippuric	≤ 14	1.5	1.5
14 DHPPA (Beneficial Bacteria)	≤ 0.23	0.09	0.09
Clostridia Bacterial Markers			
15 4-Hydroxyphenylacetic *(C. difficile, C. stricklandii, C. lituseburense & others)*	≤ 18	5.8	5.8
16 HPHPA *(C. sporogenes, C. caloritolerans, C. botulinum & others)*	≤ 102	10	10
17 4-Cresol *(C. difficile)*	≤ 39	15	15
18 3-Indoleacetic *(C. stricklandii, C. lituseburense, C. subterminale & others)*	≤ 6.8	0.74	0.74

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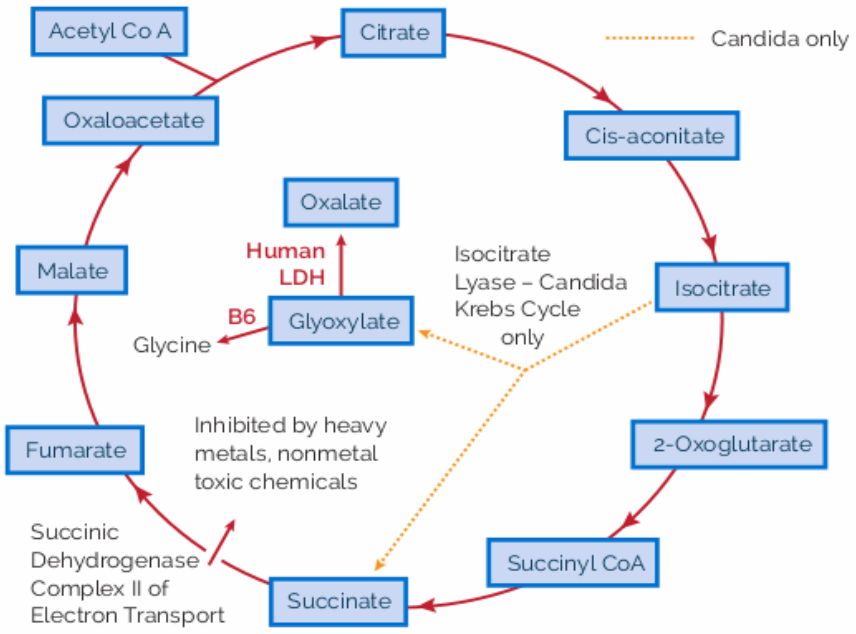
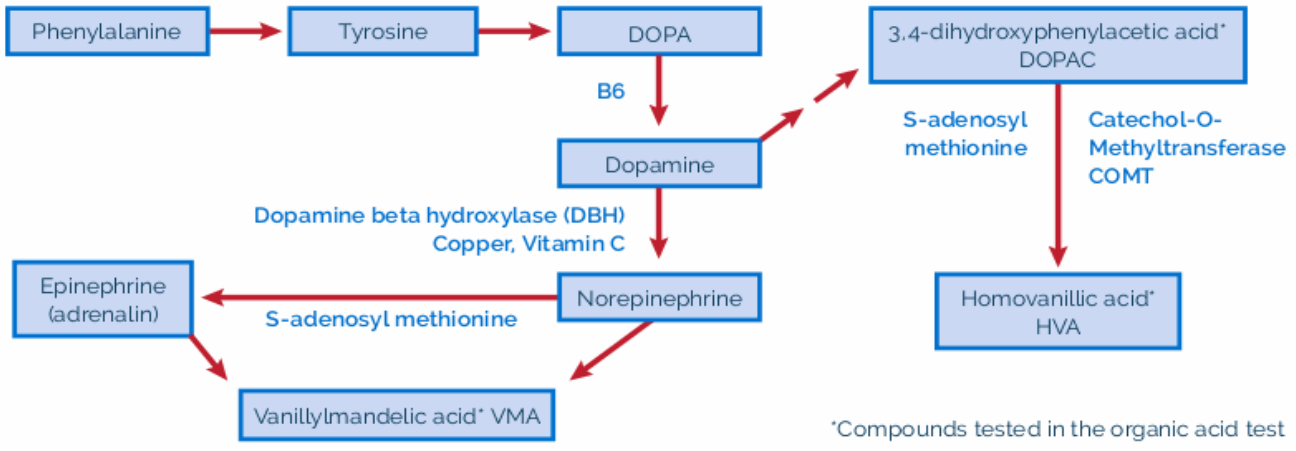
Human Krebs Cycle showing Candida Krebs Cycle variant that causes excess Oxalate via Glyoxylate



Major pathways in the synthesis and breakdown of **catecholamine neurotransmitters** in the absence of microbial inhibitors



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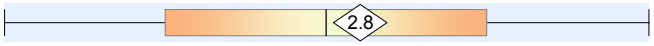
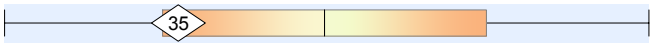
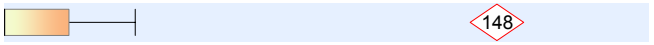
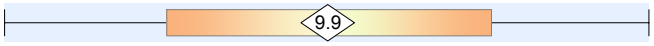
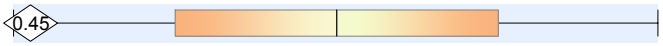
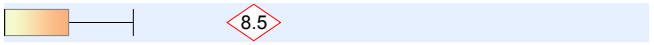
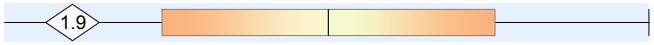
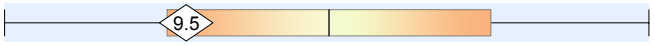
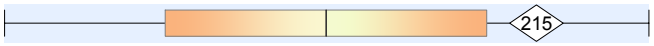
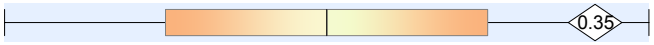
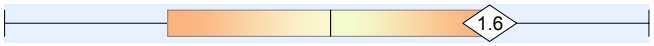
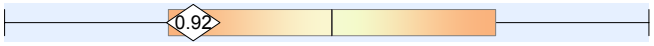
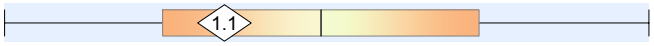
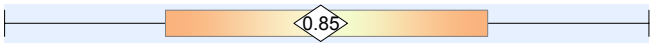
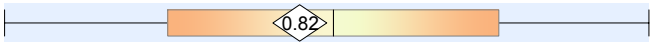
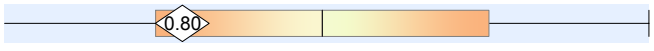
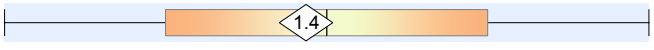
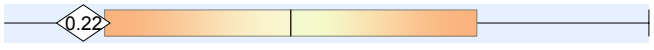
Metabolic Markers in Urine	Reference Range (mmol/mol creatinine)	Patient Value	Reference Population - Males Age 13 and Over
Oxalate Metabolites			
19 Glyceric	0.21 - 4.9	2.8	
20 Glycolic	18 - 81	35	
21 Oxalic	8.9 - 67	H 148	
Glycolytic Cycle Metabolites			
22 Lactic	0.74 - 19	9.9	
23 Pyruvic	0.28 - 6.7	0.45	
Mitochondrial Markers - Krebs Cycle Metabolites			
24 Succinic	≤ 5.3	H 8.5	
25 Fumaric	≤ 0.49	0.19	
26 Malic	≤ 1.1	0.38	
27 2-Oxoglutaric	≤ 18	1.9	
28 Aconitic	4.1 - 23	9.5	
29 Citric	2.2 - 260	215	
Mitochondrial Markers - Amino Acid Metabolites			
30 3-Methylglutaric	0.02 - 0.38	0.35	
31 3-Hydroxyglutaric	≤ 4.6	2.0	
32 3-Methylglutaconic	0.38 - 2.0	1.6	
Neurotransmitter Metabolites			
Phenylalanine and Tyrosine Metabolites			
33 Homovanillic (HVA) *(dopamine)*	0.39 - 2.2	0.92	
34 Vanillylmandelic (VMA) *(norepinephrine, epinephrine)*	0.53 - 2.2	1.1	
35 HVA / VMA Ratio	0.32 - 1.4	0.85	
36 Dihydroxyphenylacetic (DOPAC) *(dopamine)*	0.27 - 1.9	1.1	
37 HVA/ DOPAC Ratio	0.17 - 1.6	0.82	
Tryptophan Metabolites			
38 5-Hydroxyindoleacetic (5-HIAA) *(serotonin)*	≤ 2.9	0.80	
39 Quinolinic	0.52 - 2.4	1.4	
40 Kynurenic	≤ 1.8	0.22	

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Patient Name:	Daniel Jarrett	*Date of Collection:*	03/26/2023
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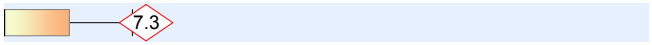
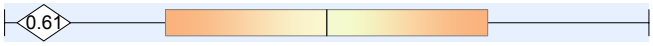
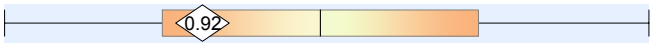
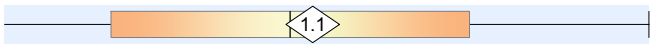
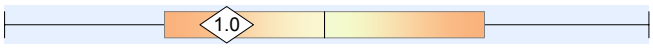
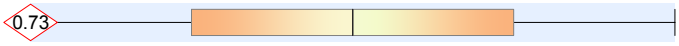
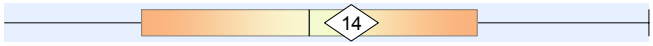
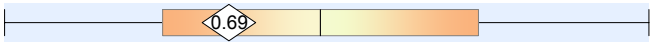
Metabolic Markers in Urine	Reference Range *(mmol/mol creatinine)*	Patient Value	Reference Population - Males Age 13 and Over
Pyrimidine Metabolites - Folate Metabolism			
41 Uracil	≤ 6.9	H 7.3	
42 Thymine	≤ 0.36	0.26	
Ketone and Fatty Acid Oxidation			
43 3-Hydroxybutyric	≤ 1.9	0.70	
44 Acetoacetic	≤ 10	0.61	
45 Ethylmalonic	0.13 - 2.7	0.92	
46 Methylsuccinic	≤ 2.3	1.1	
47 Adipic	≤ 2.9	1.0	
48 Suberic	≤ 1.9	H 3.2	
49 Sebacic	≤ 0.14	0.07	
Nutritional Markers			
Vitamin B12			
50 Methylmalonic ✱	≤ 2.3	1.3	
Vitamin B6			
51 Pyridoxic (B6)	≤ 26	2.6	
Vitamin B5			
52 Pantothenic (B5)	≤ 5.4	3.2	
Vitamin B2 (Riboflavin)			
53 Glutaric ✱	≤ 0.43	0.20	
Vitamin C			
54 Ascorbic	10 - 200	L 0.73	
Vitamin Q10 (CoQ10)			
55 3-Hydroxy-3-methylglutaric ✱	≤ 26	14	
Glutathione Precursor and Chelating Agent			
56 N-Acetylcysteine (NAC)	≤ 0.13	0.01	
Biotin (Vitamin H)			
57 Methylcitric ✱	0.15 - 1.7	0.69	

✱ ***A high value for this marker may indicate a deficiency of this vitamin.***

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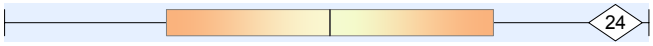
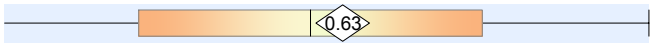
Metabolic Markers in Urine	Reference Range (mmol/mol creatinine)	Patient Value	Reference Population - Males Age 13 and Over

Indicators of Detoxification

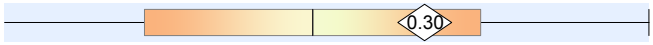
Glutathione

58	Pyroglutamic ✱	5.7 - 25		24	

Methylation, Toxic exposure

59	2-Hydroxybutyric ✱✱	≤ 1.2		0.63	

Ammonia Excess

60	Orotic	≤ 0.46		0.30	

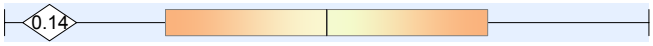
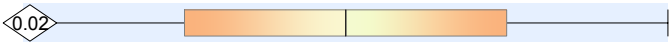
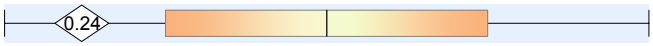
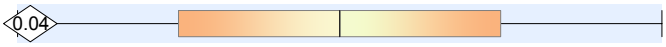
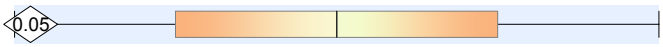
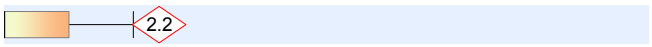
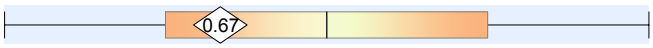
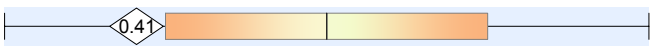
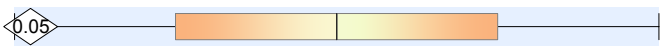
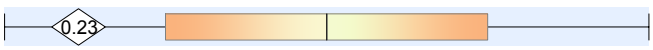
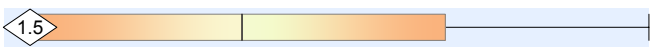
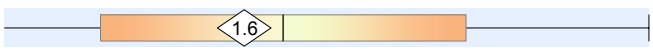
Aspartame, salicylates, or GI bacteria

61	2-Hydroxyhippuric	≤ 0.86		0.25	

✱ ***A high value for this marker may indicate a Glutathione deficiency.***

✱✱ ***High values may indicate methylation defects and/or toxic exposures.***

Amino Acid Metabolites

62	2-Hydroxyisovaleric	≤ 2.0		0.14	
63	2-Oxoisovaleric	≤ 2.0		0.02	
64	3-Methyl-2-oxovaleric	≤ 2.0		0.24	
65	2-Hydroxyisocaproic	≤ 2.0		0.04	
66	2-Oxoisocaproic	≤ 2.0		0.05	
67	2-Oxo-4-methiolbutyric	≤ 2.0		0.05	
68	Mandelic	≤ 2.0	H	2.2	
69	Phenyllactic	≤ 2.0		0.67	
70	Phenylpyruvic	≤ 2.0		0.41	
71	Homogentisic	≤ 2.0		0.05	
72	4-Hydroxyphenyllactic	≤ 2.0		0.23	
73	N-Acetylaspartic	≤ 38		1.5	
74	Malonic	≤ 9.9		6.5	
75	4-Hydroxybutyric	≤ 4.3		1.6	

Mineral Metabolism

76	Phosphoric	1,000 - 4,900		2,717	

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Indicator of Fluid Intake

77	*Creatinine	140	mg/dL

*The creatinine test is performed to adjust metabolic marker results for differences in fluid intake. Urinary creatinine has limited diagnostic value due to variability as a result of recent fluid intake. Samples are rejected if creatinine is below 20 mg/dL unless the client requests results knowing of our rejection criteria.

Explanation of Report Format

The reference ranges for organic acids were established using samples collected from typical individuals of all ages with no known physiological or psychological disorders. The ranges were determined by calculating the mean and standard deviation (SD) and are defined as ± 2SD of the mean. Reference ranges are age and gender specific, consisting of Male Adult (≥13 years), Female Adult (≥13 years), Male Child (<13 years), and Female Child (<13 years).

There are two types of graphical representations of patient values found in the new report format of both the standard Organic Acids Test and the Microbial Organic Acids Test.

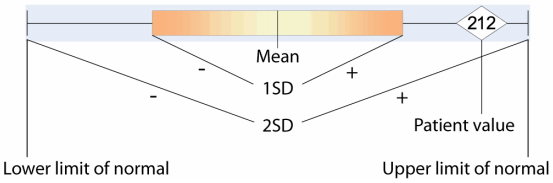
The first graph will occur when the value of the patient is within the reference (normal) range, defined as the mean plus or minus two standard deviations.

The second graph will occur when the value of the patient exceeds the upper limit of normal. In such cases, the graphical reference range is "shrunk" so that the degree of abnormality can be appreciated at a glance. In this case, the lower limits of normal are not shown, only the upper limit of normal is shown.

In both cases, the value of the patient is given to the left of the graph and is repeated on the graph inside a diamond. If the value is within the normal range, the diamond will be outlined in black. If the value is high or low, the diamond will be outlined in red.

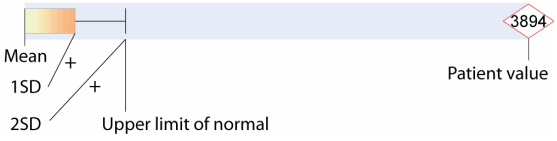
Example of Value Within Reference Range

Metabolic Markers in Urine	Reference Range (mmol/mol creatinine)		Patient Result	Reference Range - Males Age 13 and Under
Intestinal Microbial Overgrowth				
HPHPA (Clostridia marker)	<	219 .9	212	



Example of Elevated Value

Metabolic Markers in Urine	Reference Range (mmol/mol creatinine)		Patient Result	Reference Range - Males Age 13 and Under
Intestinal Microbial Overgrowth				
HPHPA (Clostridia marker)	<	219 .9	H 3894	



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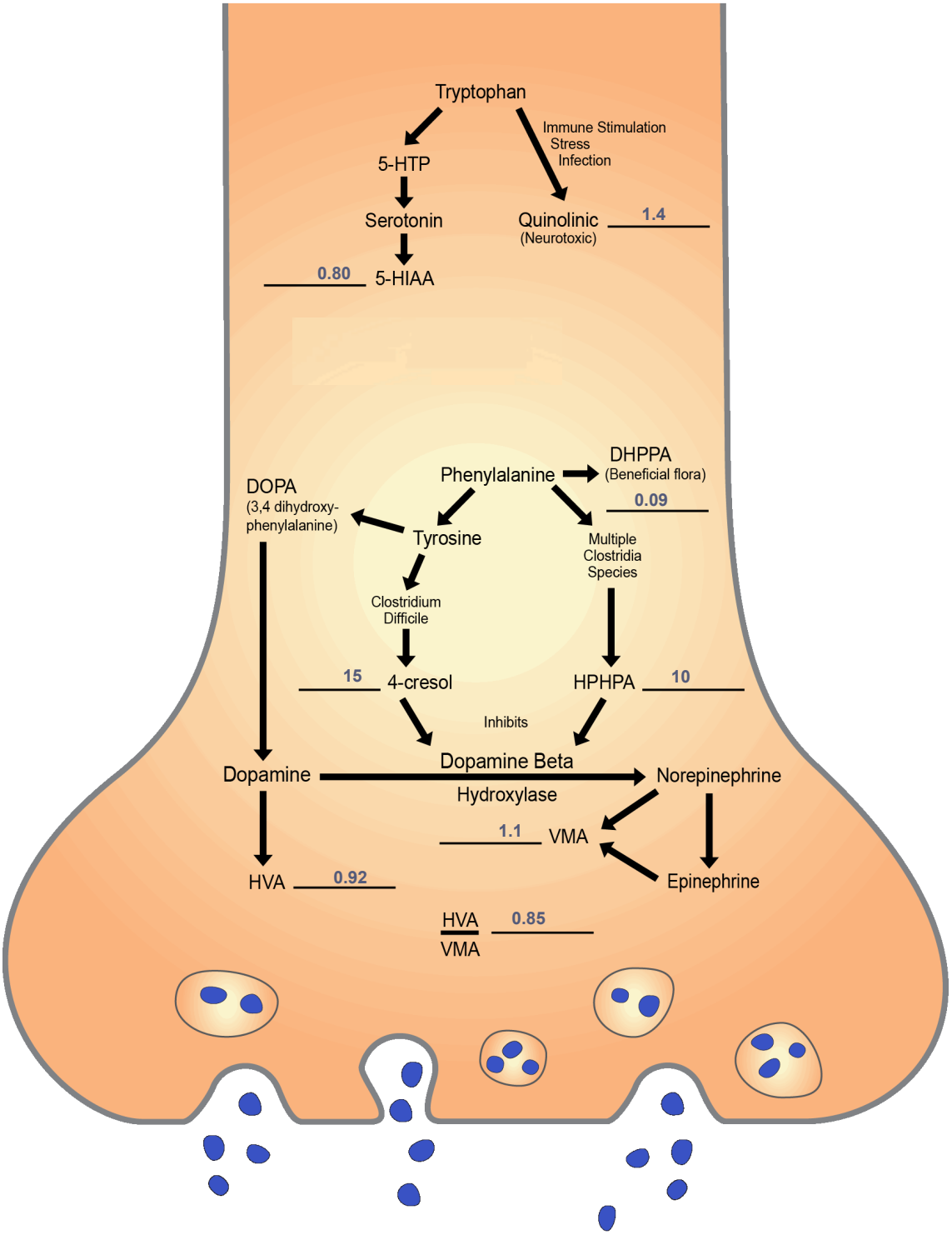
Neurotransmitter Metabolism Markers



The diagram contains the patient's test results for neurotransmitter metabolites and shows their relationship with key biochemical pathways within the axon terminal of nerve cells. The effect of microbial byproducts on the blockage of the conversion of dopamine to norepinephrine is also indicated.

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Interpretation

High yeast/fungal metabolites (1-8) Elevations of one or more metabolites indicate a yeast/fungal overgrowth of the gastrointestinal (GI) tract. Prescription or natural (botanical) anti-fungals, along with supplementation of high potency multi-strain probiotics, may reduce yeast/fungal levels.

High 2-hydroxyphenylacetic acid (11) is associated with intestinal bacteria overgrowth and higher levels with the genetic disease phenylketonuria (PKU). Additional metabolites that can become elevated in PKU include mandelic acid, phenylpyruvic, and phenyllactic. The diagnosis of PKU is more likely if the individual has an elevation in more than one of these metabolites.

High oxalic (21) with or without elevated glyceric (19) or glycolic acids (20) may be associated with the genetic hyperoxalurias, autism, women with vulvar pain, fibromyalgia, and may also be due to high vitamin C intake. However, kidney stone formation from oxalic acid was not correlated with vitamin C intake in a very large study. Besides being present in varying concentrations in most vegetables and fruits, oxalates, the mineral conjugate base forms of oxalic acid, are also byproducts of molds such as *Aspergillus* and *Penicillium* and probably *Candida*. If yeast or fungal markers are elevated, antifungal therapy may reduce excess oxalates. High oxalates may cause anemia that is difficult to treat, skin ulcers, muscles pains, and heart abnormalities. Elevated oxalic acid is also the result of anti-freeze (ethylene glycol) poisoning. Oxalic acid is a toxic metabolite of trichloroacetic acid and other environmental pollutants. In addition, decomposing vitamin C may form oxalates during transport or storage.

Elevated oxalate values with a concomitant increase in glycolic acid may indicate genetic hyperoxaluria (type I), whereas increased glyceric acid may indicate a genetic hyperoxaluria (type II). Elevated oxalic acid with normal levels of glyceric or glycolic metabolites rules out a genetic cause for high oxalate. However, elevated oxalates may be due to a new genetic disorder, hyperoxaluria type III.

Regardless of its source, high oxalic acid may contribute to kidney stones and may also reduce ionized calcium. Oxalic acid absorption from the GI tract may be reduced by calcium citrate supplementation before meals. Vitamin B6, arginine, vitamin E, chondroitin sulfate, taurine, selenium, omega-3 fatty acids and/or N-acetyl glucosamine supplements may also reduce oxalates and/or their toxicity. Excessive fats in the diet may cause elevated oxalate if fatty acids are poorly absorbed because of bile salt deficiency. Unabsorbed free fatty acids bind calcium to form insoluble soaps, reducing calcium's ability to bind oxalate and increase its absorption. If taurine is low in a plasma amino acid profile, supplementation with taurine (1000 mg/day) may help stimulate bile salt production (taurocholic acid), leading to better fatty acid absorption and diminished oxalate absorption.

High levels of oxalates are common in autism. Malabsorption of fat and intestinal *Candida* overgrowth are probably the major causes for elevated oxalates in this disorder. Even individuals with elevated glyceric or glycolic acids may not have a genetic disease. To rule out genetic diseases in those people with abnormally high markers characteristic of the genetic diseases, do the following steps: (1) Follow the nutritional steps indicated in this interpretation for one month; (2) If *Candida* is present, treat *Candida* for at least one month; (3) Repeat the organic acid test after abstaining from vitamin C supplements for 48 hours; (4) If the biochemical markers characteristic of genetic oxalate disorders are still elevated in the repeat test, consider DNA tests for the most common mutations of oxalate metabolism. DNA testing for type I hyperoxaluria is available from the Mayo Clinic, Rochester, MN as test #89915 "*AGXT* Gene, Full Gene Analysis" and, for the p.Gly170Arg mutation only, as # 83643 "Alanine:Glyoxylate Aminotransferase [*AGXT*] Mutation Analysis [G170R], Blood"). Another option to confirm the genetic disease is a plasma oxalate test, also available from the Mayo Clinic (Phone 507.266.5700). Plasma oxalate values greater than 50 micromol/L are consistent with genetic oxalate diseases and may serve as an alternate confirmation test.

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Bone tends to be the major repository of excess oxalate in patients with primary hyperoxaluria. Bone oxalate levels are negligible in healthy subjects. Oxalate deposition in the skeleton tends to increase bone resorption and decrease osteoblast activity.

Oxalates may also be deposited in the kidneys, joints, eyes, muscles, blood vessels, brain, and heart and may contribute to muscle pain in fibromyalgia. Oxalate crystal formation in the eyes may be a source of severe eye pain in individuals with autism who may exhibit eye-poking behaviors. High oxalates in the GI tract also may significantly reduce absorption of essential minerals such as calcium, magnesium, zinc, and others. In addition, oxalate deposits in the breast have been associated with breast cancer.

A low oxalate diet may also be particularly useful in the reduction of body oxalates even if dysbiosis of GI flora is the major source of oxalates. Foods especially high in oxalates include spinach, beets, chocolate, soy, peanuts, wheat bran, tea, cashews, pecans, almonds, berries, and many others.

People with abnormally high markers characteristic of the genetic diseases should do the following:
1. Avoid spinach, soy, nuts, and berries for one month.
2. If *Candida* is present, treat *Candida* for at least one month.
3. Repeat the organic acid test having abstained from vitamin C supplements for 48 hours.
4. If the biochemical markers characteristic of genetic oxalate disorders are still elevated in the repeat test, consider DNA tests for the most common mutations of oxalate metabolism.

High succinic acid (24) The most common cause of elevated succinic acid is exposure to toxic chemicals which impairs mitochondria function. The most useful tests for confirming toxic chemical exposure are **The Great Plains Laboratory GPL-TOX test** on urine for 172 chemicals and the hair metals test. Succinic acid is metabolized by the mitochondrial enzyme succinic dehydrogenase, which is significant in that it is both a Krebs cycle enzyme and a component- complex 2-of the mitochondrial electron transport chain, making this metabolite a marker of mitochondrial complex 2 as well as Krebs cycle dysfunction. A sampling of toxic chemicals that have been associated with mitochondrial dysfunction include glyphosate, 2, 4-dichlorophenoxyacetic acid (2, 4-D), organophosphate pesticides, mercury, and lead. Approximately 95% of elevated succinic acid results are associated with toxic chemical exposure. Succinic acid in the organic acid test and tiglylglycine in the **GPLTOX test** are two of the most useful markers for mitochondrial dysfunction. Tiglylglycine is a marker for mitochondrial respiratory chain complex I dysfunction while elevated succinic acid indicates respiratory complex 2 dysfunction. Occasionally both succinic acid and tiglylglycine may be elevated in mitochondrial dysfunction. Other Krebs cycle markers may also be elevated when severe chemical toxicity is present. In general, the severity of the chemical toxicity is correlated with higher values of succinic acid.

Less common causes of elevated succinic acid are mitochondrial mutations which may be due to mutations in the nuclear or the mitochondrial DNA for mitochondrial proteins such as Kearns-Sayres disorder. Succinic acid is a metabolite of gamma aminobutyric acid (GABA) so supplementation with GABA may also increase succinic acid.

Homovanillic acid (HVA) levels (33) below the mean indicate low production and/or decreased metabolism of the neurotransmitter dopamine. Homovanillic acid is a metabolite of the neurotransmitter dopamine. Low production of HVA can be due to decreased intake or absorption of dopamine's precursor amino acids such as phenylalanine and/or tyrosine, decreased quantities of cofactors needed for biosynthesis of dopamine such as tetrahydrobiopterin and vitamin B6 coenzyme or decreased amounts of cofactors such as S-adenosylmethionine (Sam-e) needed to convert dopamine to HVA. In addition, a number of genetic variations such as single nucleotide polymorphisms (SNPs) or mutations can cause reduced production of HVA due to enzymes with decreased function. HVA values below the mean but which are much higher than VMA values are usually due to impairment of dopamine beta hydroxylase due to excessive Clostridia metabolites, the mold metabolite fusaric acid, pharmaceuticals such as disulfiram, or food additives like aspartame or deficiencies of cofactors such as vitamin C or copper. Values may also be decreased in patients on monoamine oxidase (MAO) inhibitors. In addition, a number of genetic variations such as single nucleotide polymorphisms (SNPs) or mutations in MAO or COMT genes can cause reduced production of HVA. Such SNPs are available on **The Great Plains DNA methylation pathway test** which can be performed on a cheek swab.

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Vanillylmandelic acid (VMA) levels (34) below the mean indicate low production and/or decreased metabolism of the neurotransmitters norepinephrine and epinephrine. Vanillylmandelic acid is a metabolite of the neurotransmitters norepinephrine and epinephrine. Low production of VMA can be due to decreased intake or absorption of norepinephrine's and epinephrine's precursor amino acids such as phenylalanine and/or tyrosine, decreased quantities of cofactors needed for biosynthesis of norepinephrine and epinephrine such as tetrahydrobiopterin and vitamin B6 coenzyme or decreased amounts of cofactors such as S-adenosylmethionine (Sam-e) needed to convert norepinephrine and epinephrine to VMA. In addition, a number of genetic variations such as single nucleotide polymorphisms (SNPs) or mutations in MAO or COMT genes can cause reduced production of VMA. Such SNPs are available on **The Great Plains DNA methylation pathway test** which can be performed on a cheek swab. VMA values below the mean but which are much lower than HVA values are usually due to impairment of dopamine beta hydroxylase due to Clostridia metabolites, the mold metabolite fusaric acid, pharmaceuticals such as disulfiram, or food additives like aspartame or deficiencies of cofactors such as vitamin C or copper. Values may be decreased in patients on monoamine oxidase (MAO) inhibitors. Another cause for a low VMA value is a genetic variation (single nucleotide polymorphism or SNP) of the DBH enzyme. Patients with low VMA due to Clostridia metabolites or genetic DBH deficiency should not be supplemented with phenylalanine, tyrosine, or L-DOPA.

5-hydroxyindoleacetic acid (5HIAA) (38) levels below the mean may indicate lower production and/or decreased metabolism of the neurotransmitter serotonin. 5-hydroxy-indoleacetic acid is a metabolite of serotonin. Low values have been correlated with symptoms of depression. Low production of 5 HIAA can be due to decreased intake or absorption of serotonin's precursor amino acid tryptophan, decreased quantities of cofactors needed for biosynthesis of serotonin such as tetrahydrobiopterin and vitamin B6 coenzyme. In addition, a number of genetic variations such as single nucleotide polymorphisms (SNPs) or mutations can cause reduced production of 5HIAA. Such SNPs are available on **The Great Plains DNA methylation pathway test** which can be performed on a cheek swab. Values may be decreased in patients on monoamine oxidase (MAO) inhibitors that are drugs or foods that contain tyramine such such as Chianti wine and vermouth, fermented foods such as cheeses, fish, bean curd, sausage, bologna, pepperoni, sauerkraut, and salami.

High uracil (41) can be associated with disorders of folate metabolism, folate deficiency, and genetic disorders of pyrimidine metabolism. Genetic disorders of pyrimidine metabolism are more common when uracil exceeds 50 mmol/mol creatinine and thymine is also elevated. An autistic child with a uracil value >300 mmol/ mol creatinine and diffuse demyelination of the brain was treated with high levels of folate which normalized the uracil but did not improve the clinical symptoms.

Slight elevation in suberic acid (48) is consistent with overnight fasting or increased fat in the diet. Regardless of cause, supplementation with L-carnitine or acetyl-L-carnitine may be beneficial.

Pyridoxic acid (B6) levels below the mean (51) may be associated with less than optimum health conditions (low intake, malabsorption, or dysbiosis). Supplementation with B6 or a multivitamin may be beneficial.

Ascorbic acid (vitamin C) levels below the mean (54) may indicate a less than optimum level of the antioxidant vitamin C. Individuals who consume large amounts of vitamin C can still have low values if the sample is taken 12 or more hours after intake. Supplementation with buffered vitamin C taken 2 or 3 times a day is suggested.

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High mandelic acid (68) usually results from exposure to styrene. Mandelic acid in urine samples of people exposed to styrene ranges from less than 4 to 2200 mmol/mol creatinine. Mandelic acid is the major metabolite of styrene. Styrene (phenethylene or vinylbenzene) is used as an intermediate in plastic synthesis. Values less than 5 mg/L are due to normal metabolism of phenylalanine or tyrosine.

High concentrations of styrene cause central nervous system depression, nausea, headache, fatigue, and liver damage. When exposed to 100 ppm of styrene in air, mandelic acid in urine was found to average 1700 mmol/mol creatinine. Mandelic acid is also a metabolite of ethylbenzene, and of some antispasmodic and vasodilator drugs. Normal phenyllactic and phenylpyruvic acids indicate that styrene or drug exposure is more likely than PKU as a cause of these abnormalities. Dopamine metabolism is a target for the neurotoxic effects of some monocyclic aromatic hydrocarbons and their metabolites. Reduce exposure by eliminating plastic and styrofoam containers for cooking, reheating, eating or drinking (especially warm or hot) food or beverages. Replace these containers with glass, paper, or stainless steel whenever possible. Elimination of styrene can be accelerated by sauna treatment, reduced glutathione supplementation (oral, intravenous, transdermal, precursors such as N-acetyl cysteine [NAC]). High values of mandelic acid also occur in phenylketonuria (PKU). Additional metabolites that can become elevated in PKU include 2-hydroxyphenylacetic, phenylpyruvic, and phenyllactic acids. The diagnosis of PKU is more likely if the individual has an elevation in more than one of these metabolites. Measuring serum phenylalanine will rule out PKU. Other causes may be increased dietary phenylalanine or phenylalanine supplements. Ascorbic acid deficiency may also be related to this abnormality since ascorbic acid is a cofactor for phenylalanine hydroxylase. Individuals with any form of PKU may benefit from supplementation with 1000mg/day or more of ascorbic acid (vitamin C).

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